

SUPER TYPHOON FRED (19W)

I. HIGHLIGHTS

As Typhoon Ellie (18W) approached southwestern Japan, the embryo of Super Typhoon Fred was developing about 1200 nm (2200 km) to the southeast. The developing system moved west-southwestward for four days, reaching typhoon intensity on 16 August. Like Doug (17W), which occurred earlier in the month, Fred reached super typhoon intensity without going through an episode of rapid intensification. Near the southern Ryukyu Islands, Fred began to weaken from its 130 kt (67 m/sec) peak intensity and veered to the northwest. It passed about 120 nm (220 km) north of Taipei before the system resumed a west-northwestward track and continued to weaken. Fred's landfall on mainland China on 21 August near the city of Wenzhou coincided with an unusually high astronomical tide, generating some of the highest tides of the last two decades in that region. Resultant flooding and strong winds took an estimated 1,000 lives in Wenzhou alone.

II. TRACK AND INTENSITY

The tropical disturbance that would become Fred was first mentioned on the 130600Z August Significant Tropical Weather Advisory. It initially tracked toward the west-southwest, equatorward of the mid-level subtropical ridge. The disturbance continued to develop, a Tropical Cyclone Formation Alert was issued at 140400Z followed by the first warning at 140600Z. On the morning of 15 August, Tropical Depression 19W was upgraded to Tropical Storm Fred. For the next five days the storm intensified at a rate of 20 kt (10 m/sec) per day, reaching typhoon intensity on the night of 16 August (Figure 3-19-1) and super typhoon intensity on the night of 19 August (Figure 3-19-2).

When Fred became a super typhoon, it was heading to the west-northwest on a course toward Taiwan. About 250 nm (460 km) southwest of Okinawa, Fred began to rapidly weaken, and veered north-northwestward passing to the north of Taiwan. The period of north-northwestward motion was short-lived, leading to passage between Ishigaki-jima (WMO 47918) and Miyako-jima (WMO 47927) (Figure 3-19-3). After passing through the southern Ryukyu islands, Fred resumed its previous west-northwestward heading, and continued to weaken (but at a much slower rate) as it approached mainland China. At 211200Z, Nanji Shan (WMO 58765) (a small island about 120 nm southeast of Wenzhou) recorded ten-minute sustained winds of 80 kt (41 m/sec) (92 kt one-minute average sustained wind) and a sea-level pressure of 956.7 mb (Figure 3-19-5). The final warning was issued at 220600Z as Fred dissipated over the Yangtze River valley near Wuhan.

III. DISCUSSION

a. Rate of intensification

Most super typhoons undergo a period of rapid intensification (Mundell 1990); where rapid intensification is defined as a 24-hour period during which the central pressure falls by at least 42 mb. However, Fred did not go through a period of rapid intensification (Table 3-19-1). In addition, the eye did not shrink significantly as usually occurs with rapid intensification, nor did it expand and develop a very thick eye wall as did Doug (17W). In fact, the size of the eye vacillated considerably (Table 3-19-2). Beginning on 15 August at 1200Z, Fred moved westward in tandem with a TUTT cell to its northeast. The effects (if any) of TUTT cells upon tropical cyclone motion and intensity are not well-understood.

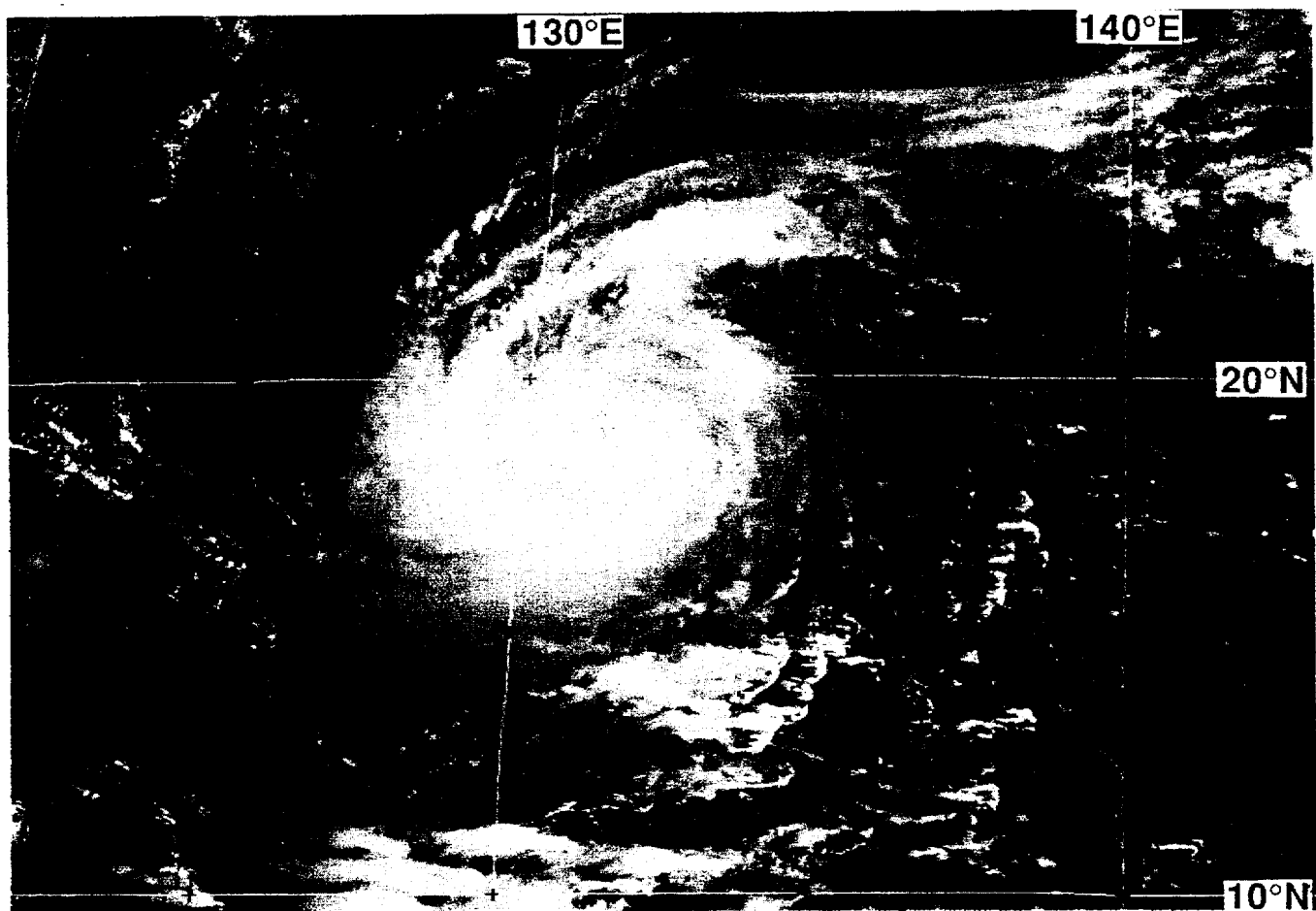


Figure 3-19-1 Fred attains typhoon intensity (172331Z August visible GMS satellite imagery).

b. Rate of weakening

Fred weakened rapidly following its peak of 130 kt (67 m/sec). This rapid weakening is substantiated by the observed minimum pressure and maximum wind during eye passage over Ishigaki-jima (WMO 47918), and by the maximum winds seen at Miyako-jima (see Figure 3-19-4). After leaving these stations, however, it appears that the rate of weakening slowed to less than 5 kt (2.6 m/sec) per 6-hour interval, since 92 kt (converted 1-min average) maximum sustained winds were observed at Nanji Shan (WMO 58765), China, as Fred struck the coast. Since this report was obtained at the synoptic hour of 211200Z it is likely that it represents neither the maximum wind nor the lowest pressure in Fred's core at landfall.

As with Doug (17W), Fred's eye did not expand after reaching peak intensity (Table 3-19-2). After 201800Z, the eye diameter began to shrink from 32 nm (59 km) to 11 nm (20 km) before it disappeared from the satellite imagery.

IV. IMPACT

No information was received concerning damage from Fred in the southern Ryukyu Islands. Damage in China was summarized in the August 31, 1994 Weekly Climate Bulletin of the U.S. National Climate Analysis Center of NOAA:

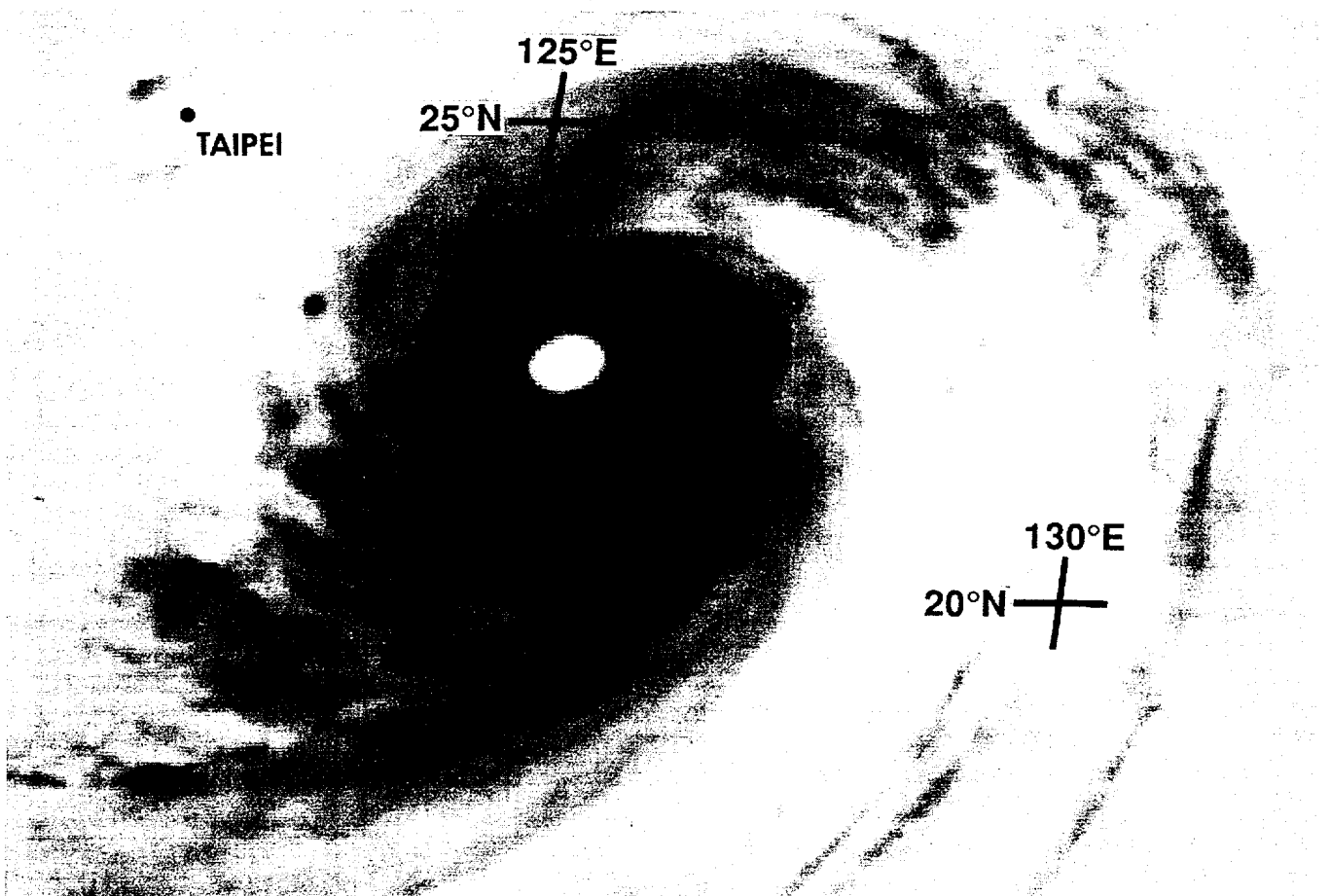


Figure 3-19-2 Fred at its peak intensity of 130 kt (67 m/sec) (191831Z August inverse infrared GMS imagery). Note: in an inverse infrared image, the cold clouds are dark and the warm sea surface is white.

“Typhoon Fred, packing wind gusts over 295 kph [160 kt] at one time, slowly weakened as it tracked north of Taiwan and into southern Zhejiang province in China. Generally, 100-225 mm (3.9-8.9 in) of rain fell along and near the path of the storm, flooding large sections of northern Taiwan and southern Zhejiang province. According to press reports, Fred’s landfall near the city of Wenzhou coincided with an unusually high astronomical tide, thereby generating some of the highest tides of the last two decades in and near Wenzhou. Resultant flooding combined with strong winds to take an estimated 1,000 lives in Wenzhou alone, according to city officials. In addition, local officials indicated that Fred, the region’s worst storm in over a century, demolished 100,000 homes, damaged another 700,000 dwellings, isolated more than two million individuals, forced the closure of Wenzhou airport for at least two weeks, damaged over 3000 km² (875 mi²) of farmland, caused flooding in more than 180 towns, and forced 90,000 enterprises to suspend production. Total economic losses may top \$1.2 billion (U.S.).”

Table 3-19-1 Twenty-four hour pressure fall for each 6-hour interval during the intensification of Typhoon Fred. Winds are in knots and represent best-track winds; pressures are in millibars and are derived from winds using the Atkinson-Holliday wind-pressure relationship (Atkinson and Holliday 1977).

Time (Z)	24-hr Wind Range	24-hr Pressure Range	24-hr Pressure Fall
1600-1700	55-75 kt	984-968 mb	16 mb
1606-1706	60-80	980-963	17
1612-1712	65-85	976-959	17
1618-1718	70-90	971-954	17
1700-1800	75-95	968-949	19
1706-1806	80-100	963-943	20
1712-1812	85-110	961-932	29
1718-1818	90-115	954-927	27
1800-1900	95-120	949-922	27
1806-1906	100-125	939-916	23
1812-1912	110-130	932-910	22
1818-1918	115-125	927-916	11

Table 3-19-2 Comparison of Dvorak T-number, best track intensity and infrared eye diameter for Typhoon Fred from initial 55 kt (28 m/s) intensity to after landfall in China.

Date/Time (Z)	T-number	Intensity (kt)	Eye Diam (nm)
160000	3.5	55	NA
160600	3.5	60	NA
161200	4.0	65	27
161800	4.5	70	24
170000	5.0	75	25
170600	5.0	80	17
171200	5.0	85	29
171800	5.0	90	24
180000	5.0	95	22
180600	5.0	100	21
181200	6.0	110	16
181500	6.0	115	16
181800	6.0	115	25
182100	6.0	120	35
190000	6.0	120	24
190300	6.0	120	29
190600	6.5	125	30
190900	6.5	125	30
191200	7.0	130	33
191800	6.0	125	38
200000	6.0	120	32
200600	5.5	110	26
201200	6.0	105	34
201800	5.0	100	26
210000	4.5	95	18
210600	4.5	95	11
211200	4.0	90	NA
211800	4.0	80	NA

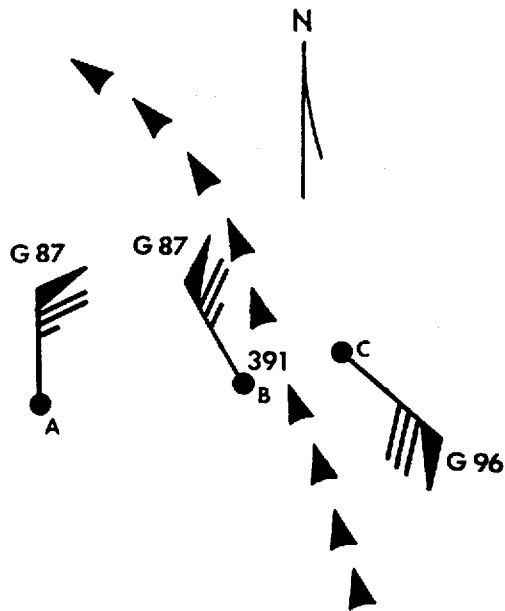


Figure 3-19-3 Wind and pressure data at Yonaguni-jima (WMO 47912) (labeled A), Ishigaki-jima (WMO 47918) (labeled B), and Miyako-jima (WMO 47927) (labeled C) at 201200Z. Peak 10-minute sustained winds are plotted and peak gusts are indicated. The pressure of 939.1 mb recorded at Ishigaki-jima is plotted as 391. The track of Fred is indicated by the trail of arrows.

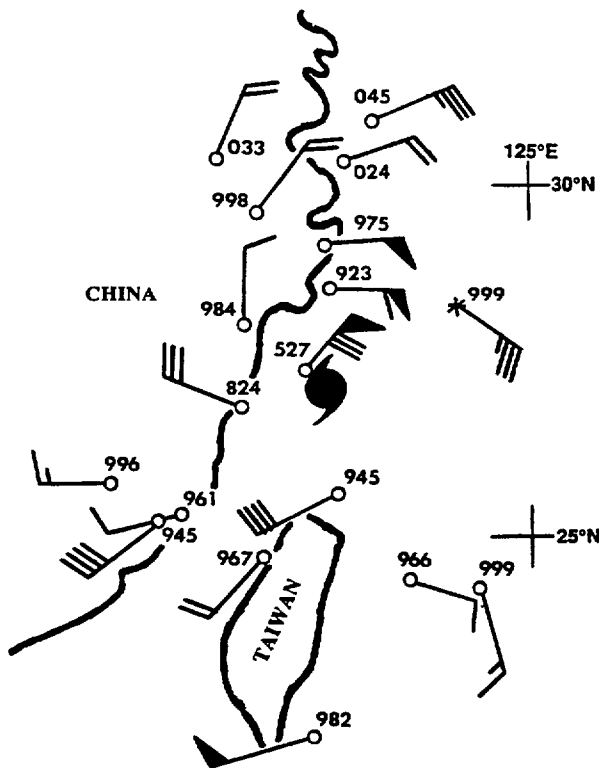


Figure 3-19-4 Synoptic reports at 211200Z August as Fred makes landfall on the east coast of China. Winds are 10-minute sustained averages.